



# AIRS Level 2 Convective Products

Fengying Sun, Christopher Barnet,  
Eric Maddy and Lihang Zhou

# Outline of talk



1. *Motivation*
2. *What are convective parameters?*
3. *Comparison with GOES products*
4. *Relation to severe weather*
5. *Summary and future plans*

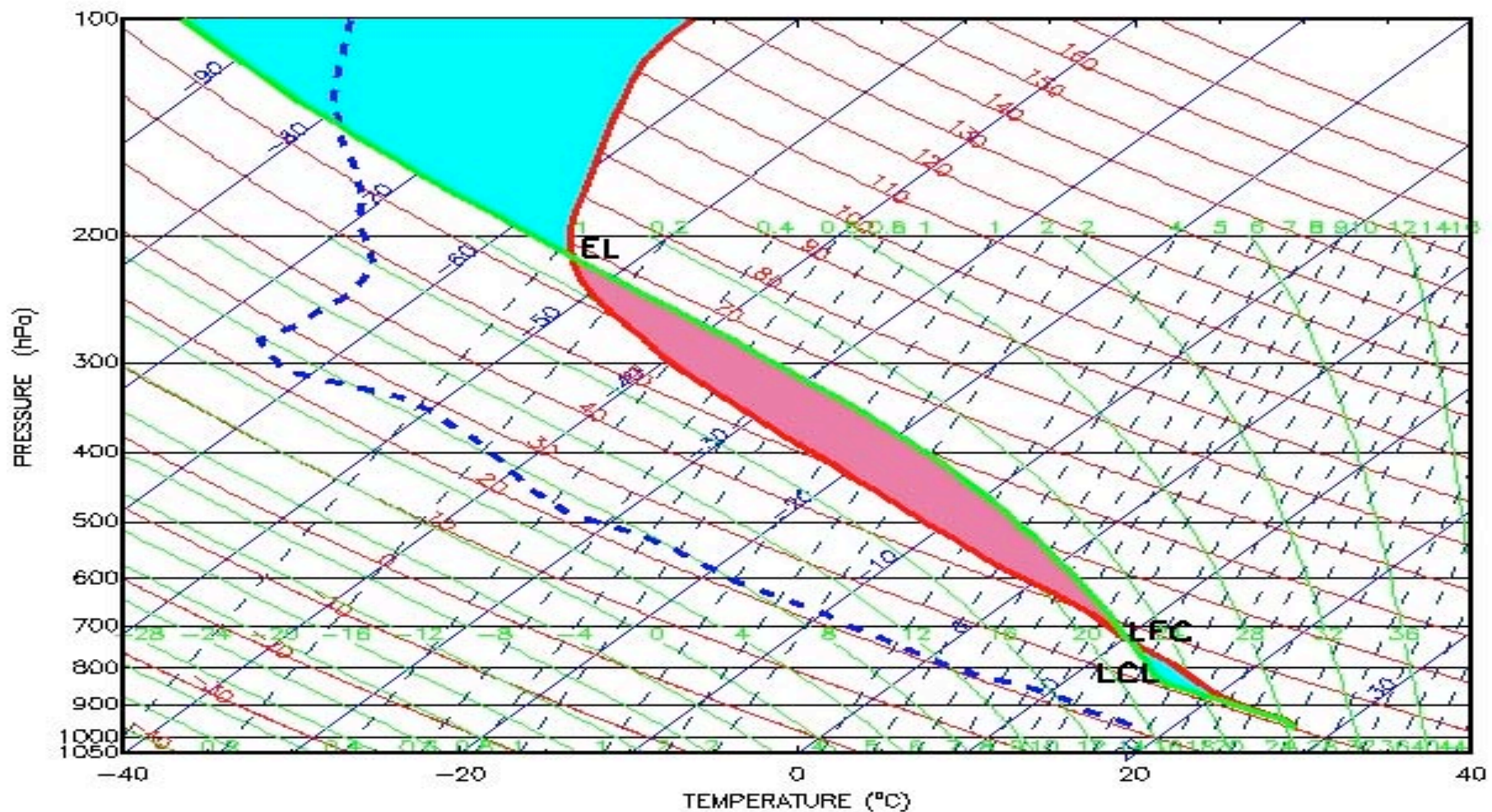
# Motivation



- CAPE (Convective Available Potential Energy), CIN (Convective Inhibition) and LI (*Lifted Index*) are routine products for GOES
- Derived from temperature and moisture profiles from MIT, regression and physical algorithms
- Wanted to see if 50km retrieval products could supply useful information
- Convective products provide awareness of convective potential in evolving storm environments

# *What are convective parameters?*

*Parcel method and skew-T log(p) diagram*



# *CAPE: Convective Available Potential Energy (Positive Area)*



$$\text{CAPE} = g \int_{z=\text{LFC}}^{z=\text{EL}} \frac{\bar{T}_v - T_v}{T_v} dz$$

The amount of energy available to a parcel as it freely rises between LFC and EL.

0 – 1000	marginally unstable
1000 – 2500	moderately unstable
2500 – 3500	very unstable
≥ 3500	extremely unstable

# *CIN: Convective Inhibition (Negative Area)*



$$\text{CIN} = g \int_{z=\text{SFC}}^{z=\text{LFC}} \frac{\bar{T}_v - T_v}{T_v} dz$$

The amount of energy that must be supplied to a parcel for it to rise to LFC.

< 15	fair weather cumulus field (CIN overcome early)
15 – 50	a few strong thunderstorms may form (if CIN is overcome)
50 – 150	strong thunderstorms may form (if CIN is overcome)
> 200	strong capping inversion present and thunderstorm development unlikely (CIN usually difficult to overcome)

# *LI: Lifted Index*



$$LI = T500 - T_{p500}$$

The difference between the 500 hPa temperature (T500) and the lifted parcel's temperature (T<sub>p</sub>500).

> 0	stable conditions, but convection possible for LI = 1 – 3 if strong lifting is present
0 – -3	marginally unstable
-3 – -6	moderately unstable
-6 – -9	very unstable
< -9	extremely unstable

# Algorithm



Investigating the differences between the many methods calculating CAPE and other stability indices.

- Origin of parcel (surface,  $\max(\theta_e)$ ,  $\max(\text{CAPE})$ ).
- Formulation of saturation vapor pressure.
- Formulation of  $\theta_e$  : Many formulations out there (Simpson, Betts, Bolton, Holton, etc).

→ **Our implementation based on McIDAS**

# FORTRAN Subroutine



## conv\_parat

(iprt,pres,temp,wcd,psurf,liftflag,nstabil,stabil)

*CAPE: Convective Available Potential Energy (J/kg)*

*CIN: Convective Inhibition (J/kg)*

*LI: Lifted Index (T500-Tp500) (C)*

*LCL: Pressure at the Lifted Condensation level (hPa)*

*LFC: Pressure at the Level of Free Convection (hPa)*

*EL: Pressure at the Equilibrium level (hPa)*

*TLCL: Temperature at LCL (K)*

*TLFC: Temperature at LFC (K)*

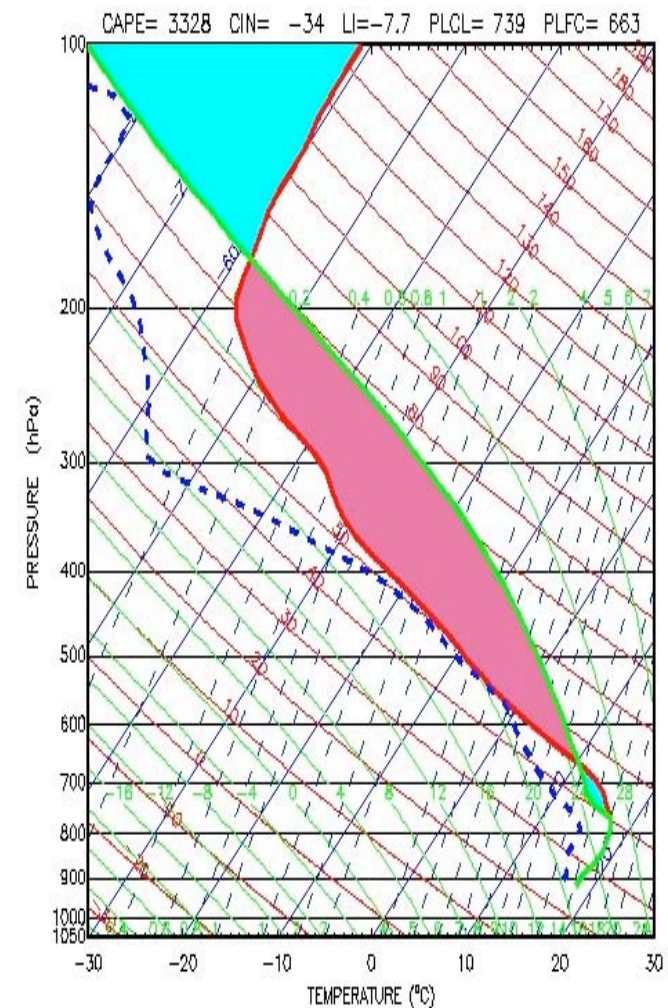
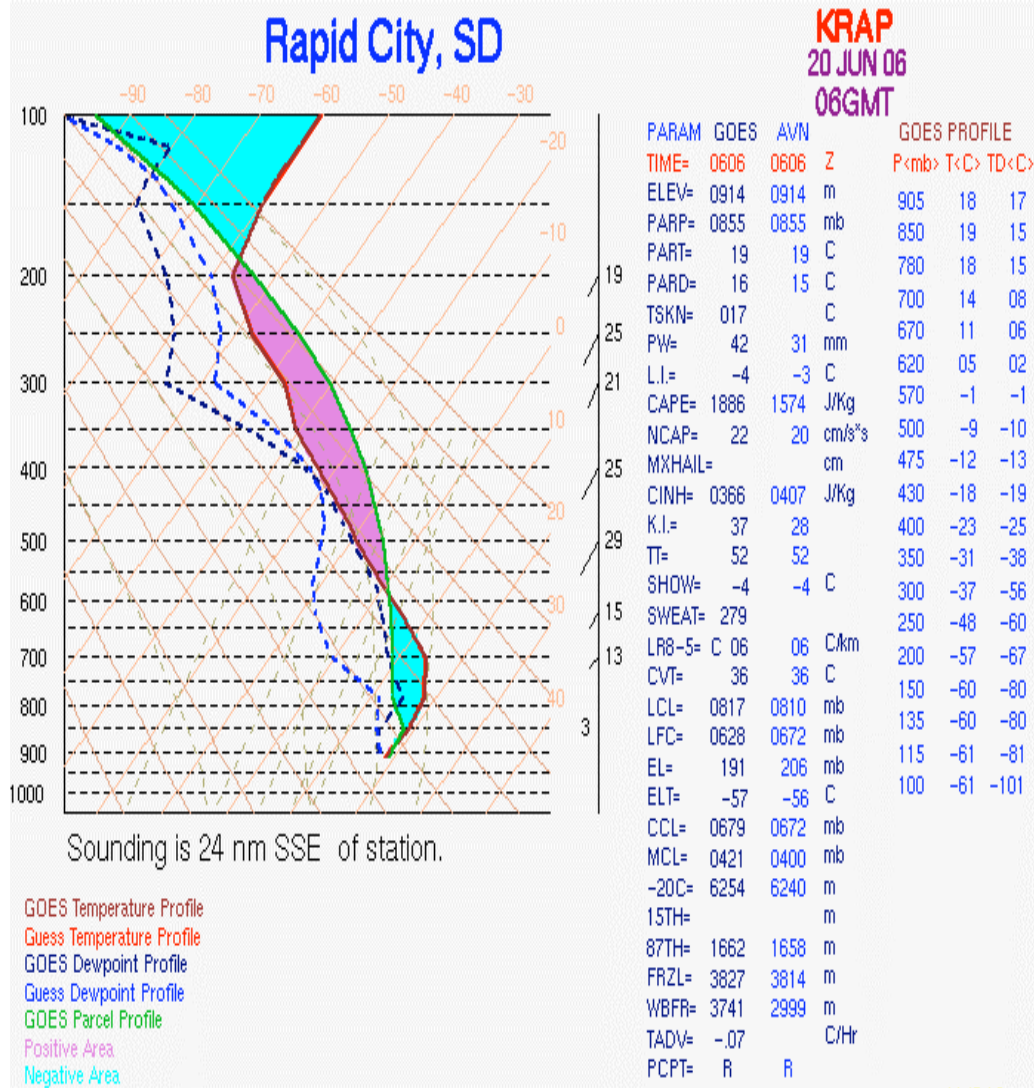
*$\theta$ : potential temperature of the lifted parcel (K)*

*$\theta_e$  : Equivalent potential temperature of the lifted parcel (K)*

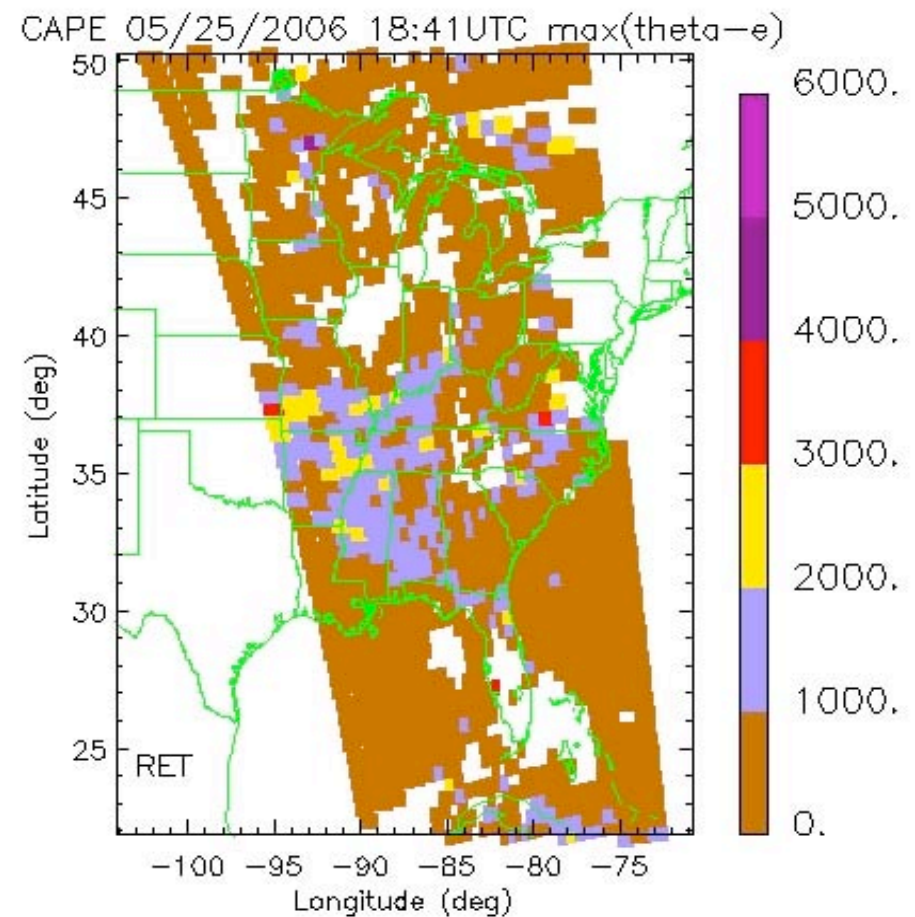
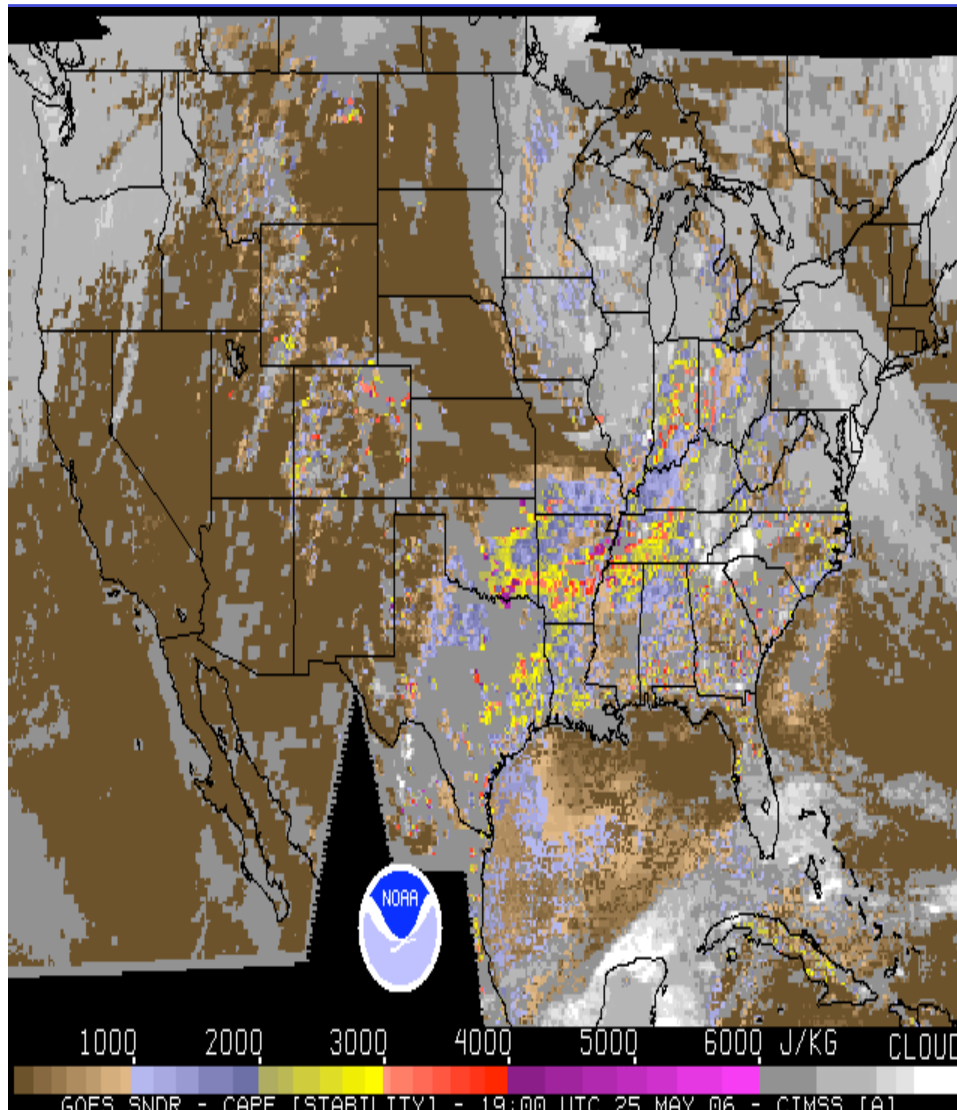


# **Comparison with GOES products**

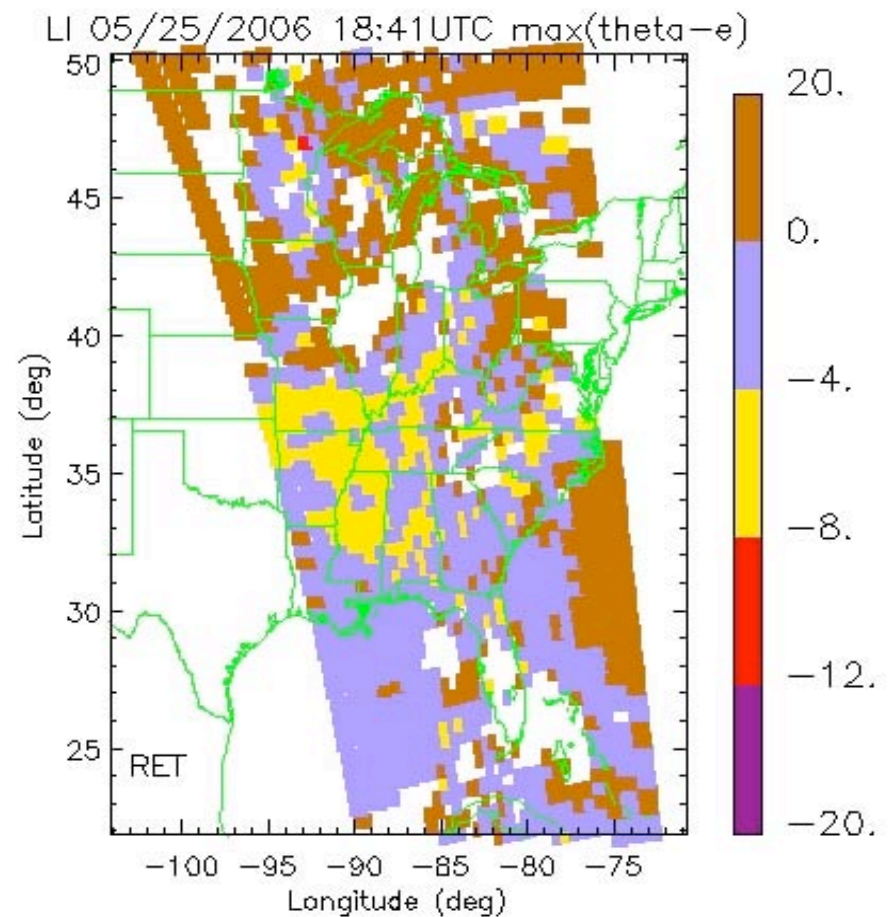
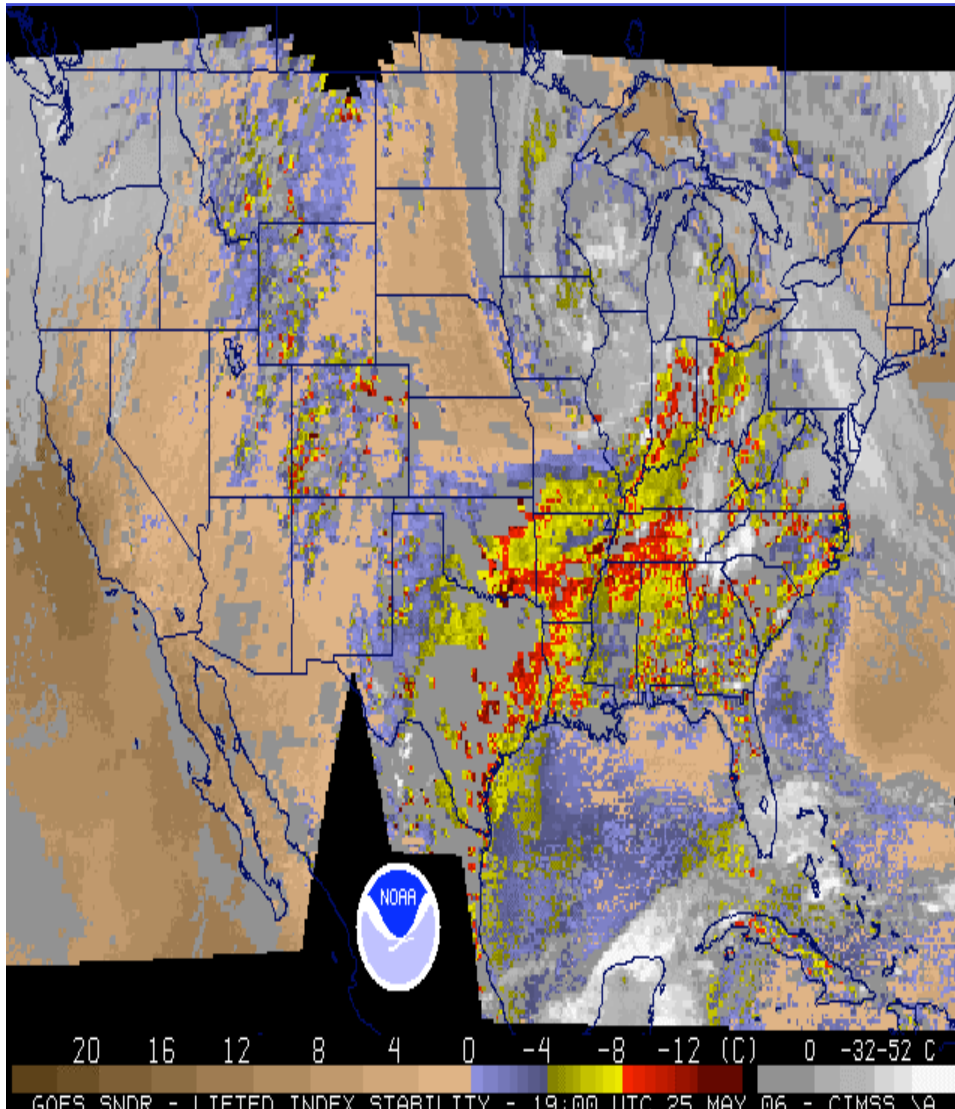
# Comparison of NOAA/NESDIS GOES Sounder Temperature and Moisture Products (left) and AIRS products (right)



# CAPE from CIMSS Realtime GOES Products (left) and AIRS products (right)



# LI from GOES sounding (CIMSS/SSEC, left) and AIRS (right)





# **Relation to severe weather**

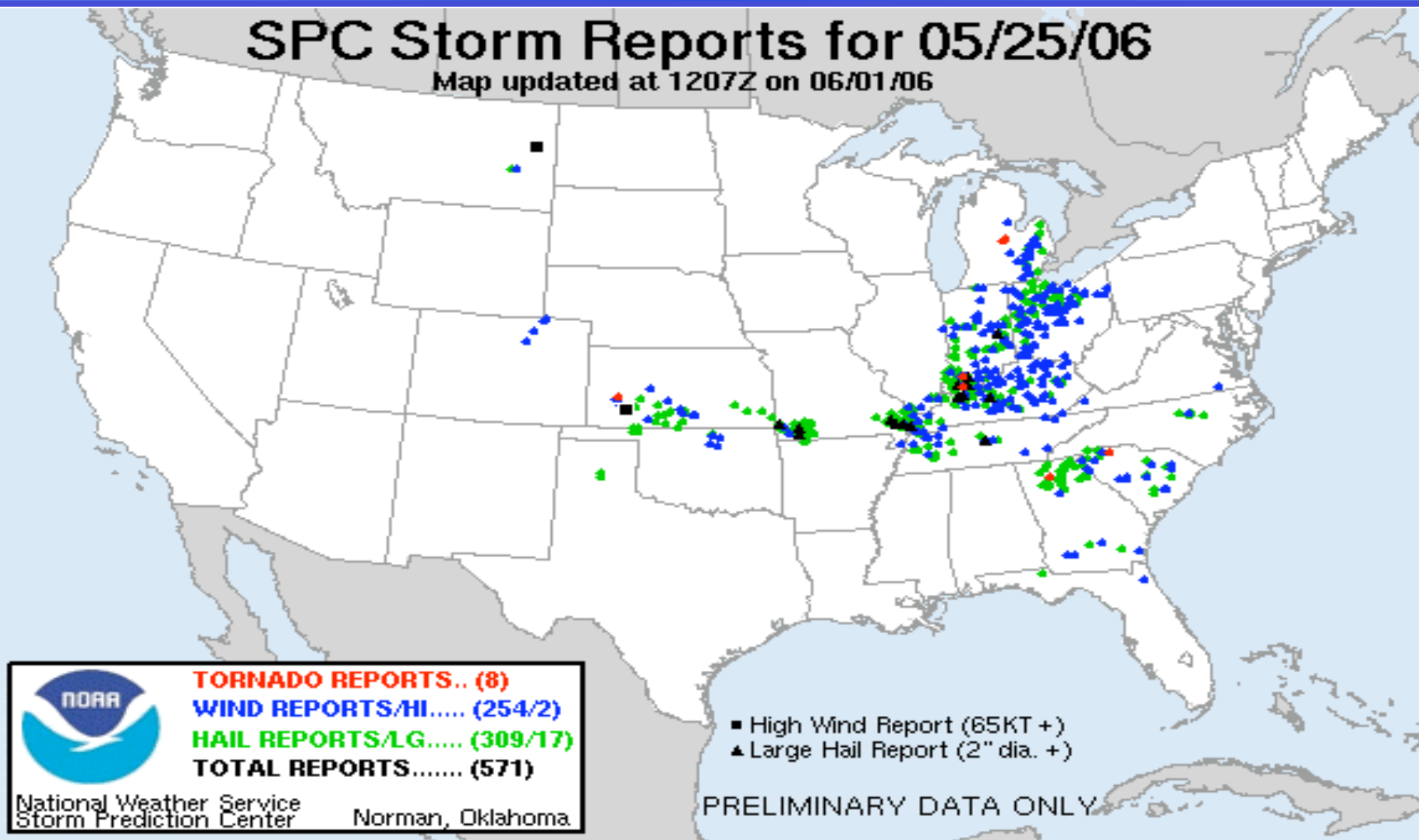
# Tornado, wind and hail reports (SPC)

from 05/25/06 12Z to 05/26/06 12Z



## SPC Storm Reports for 05/25/06

Map updated at 1207Z on 06/01/06



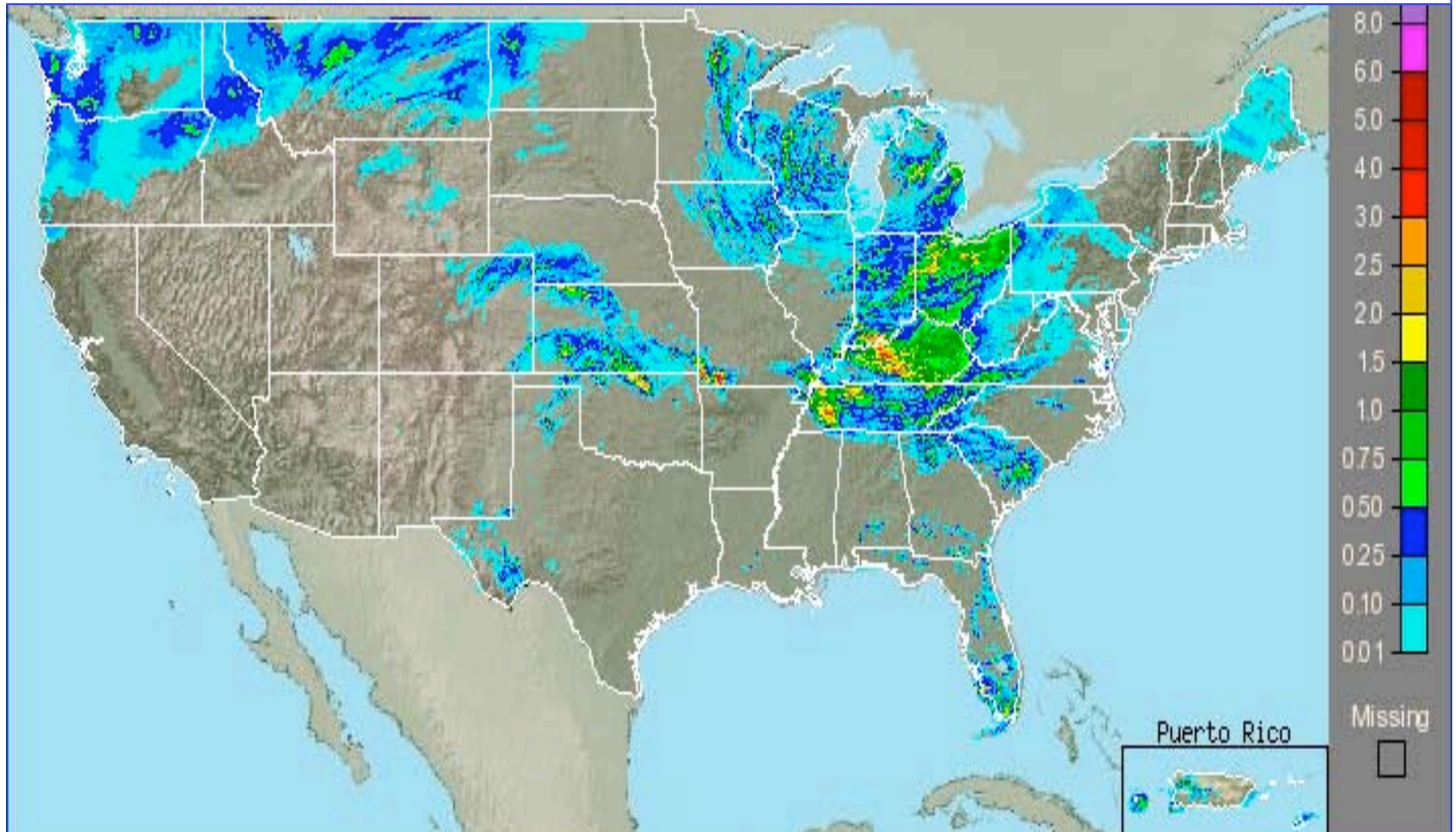
**TORNADO REPORTS.. (8)**  
**WIND REPORTS/HI..... (254/2)**  
**HAIL REPORTS/LG..... (309/17)**  
**TOTAL REPORTS..... (571)**

■ High Wind Report (65KT +)  
▲ Large Hail Report (2" dia. +)

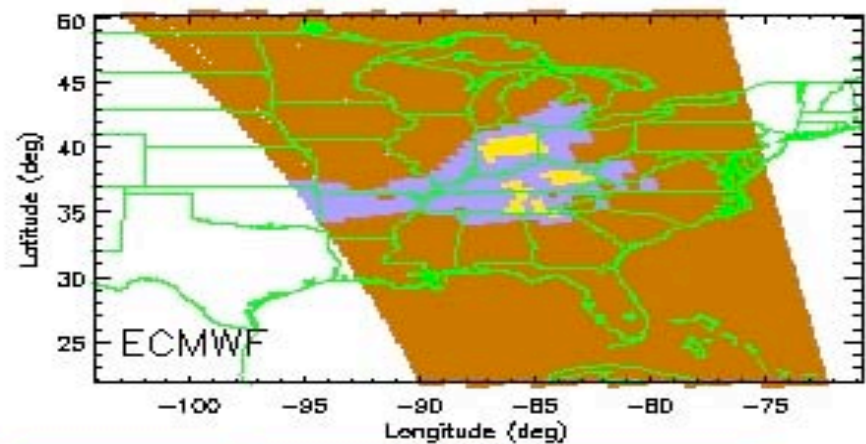
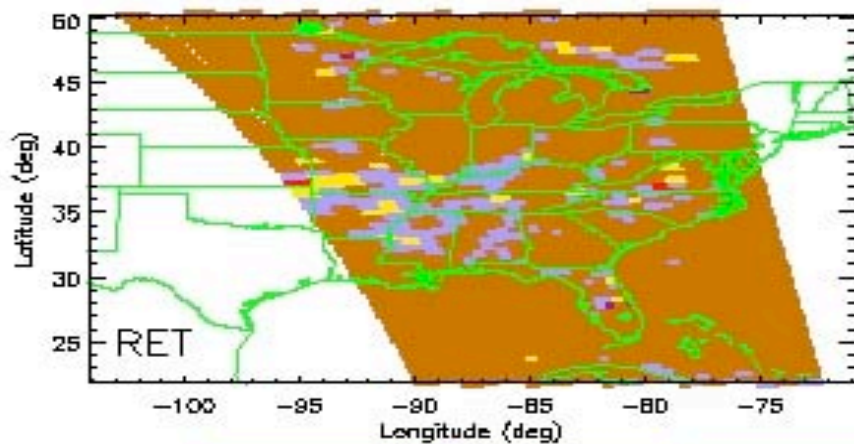
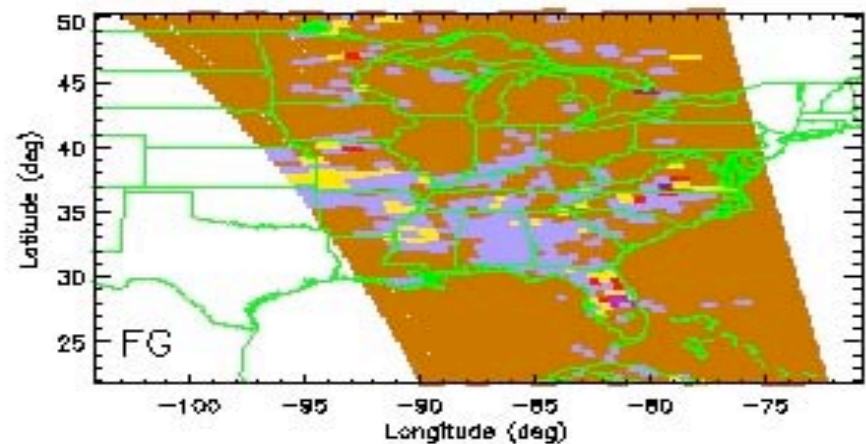
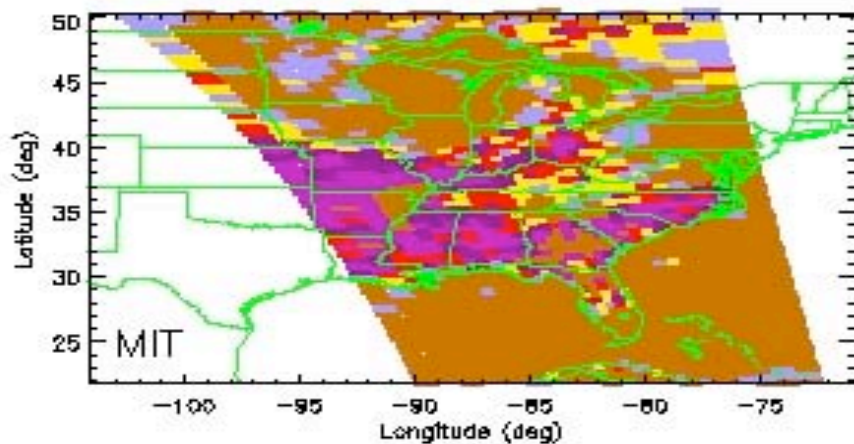
PRELIMINARY DATA ONLY

# Daily observed precipitation (NWS)

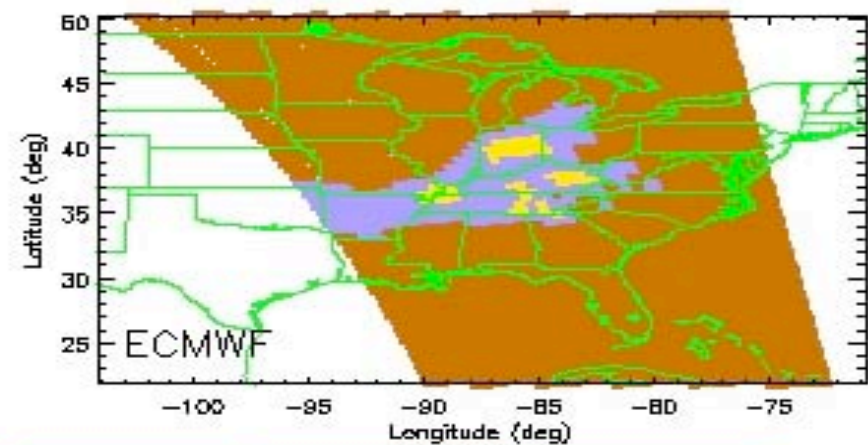
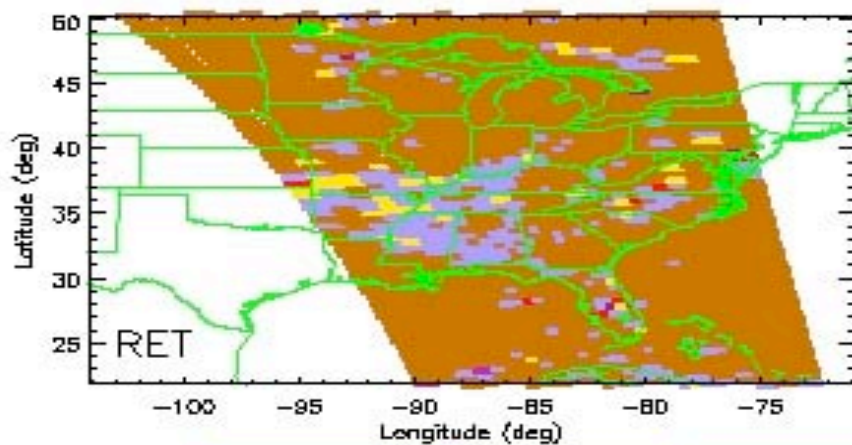
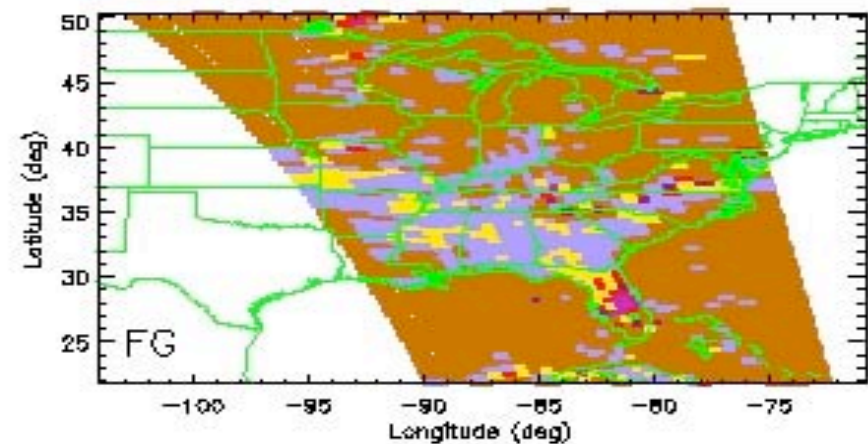
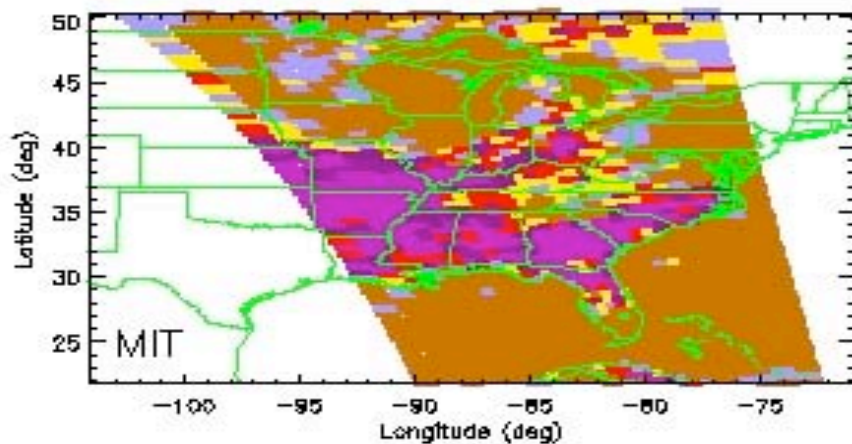
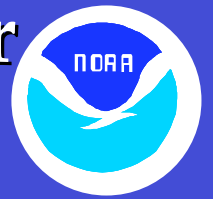
from 05/25/06 12Z to 05/26/06 12Z



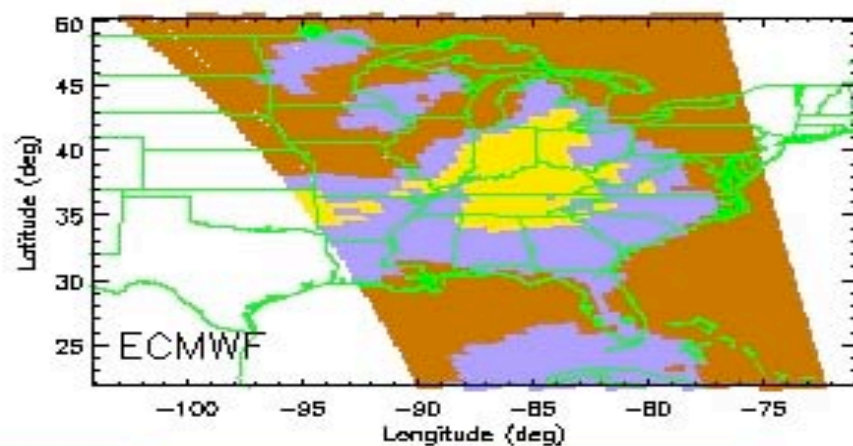
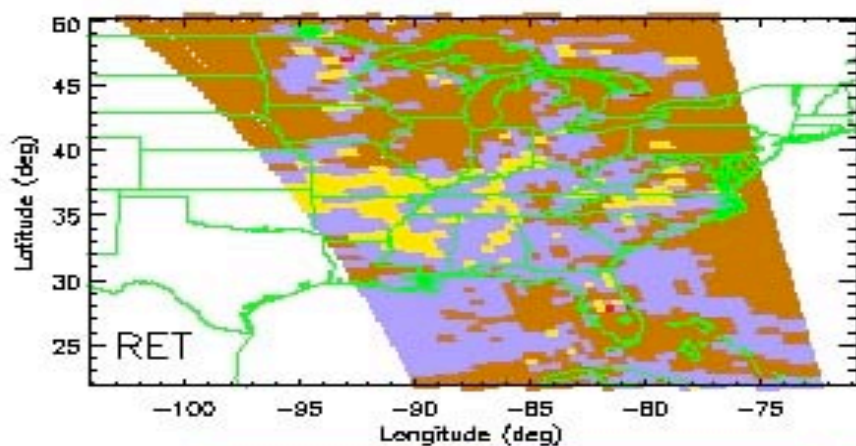
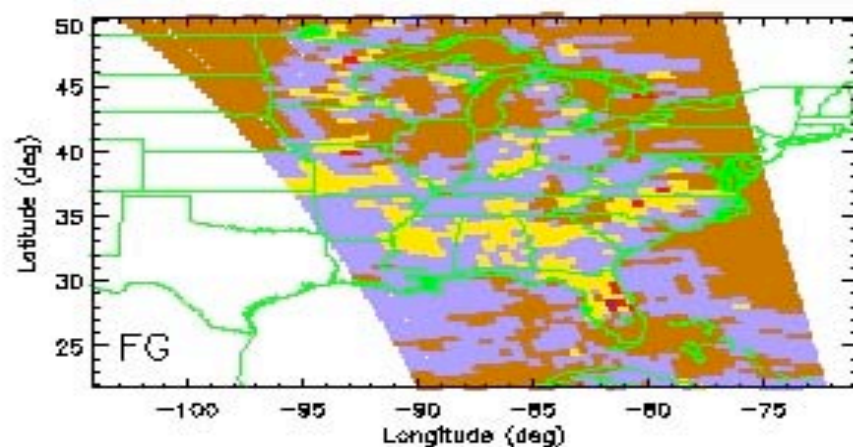
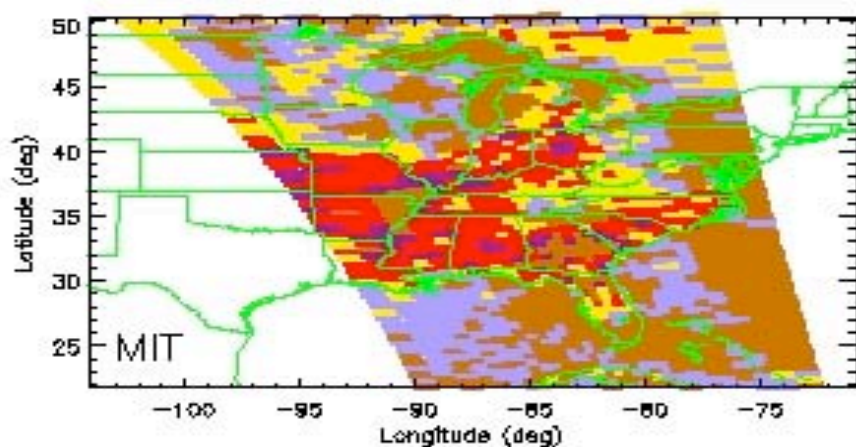
# Surface-based CAPE: Lift parcel from surface



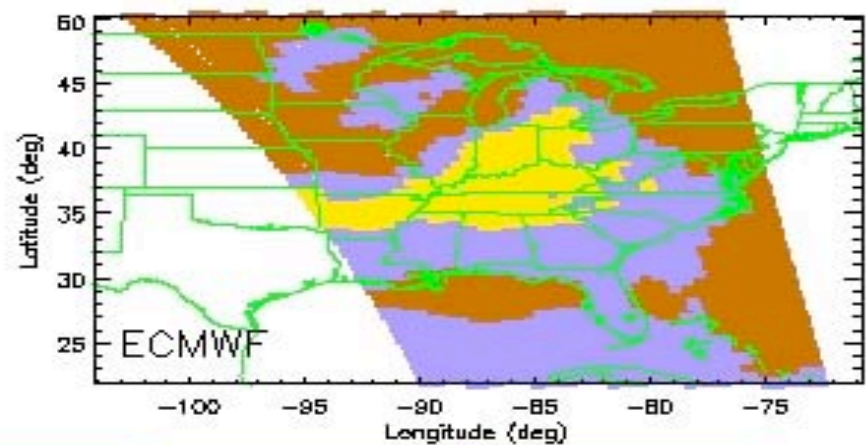
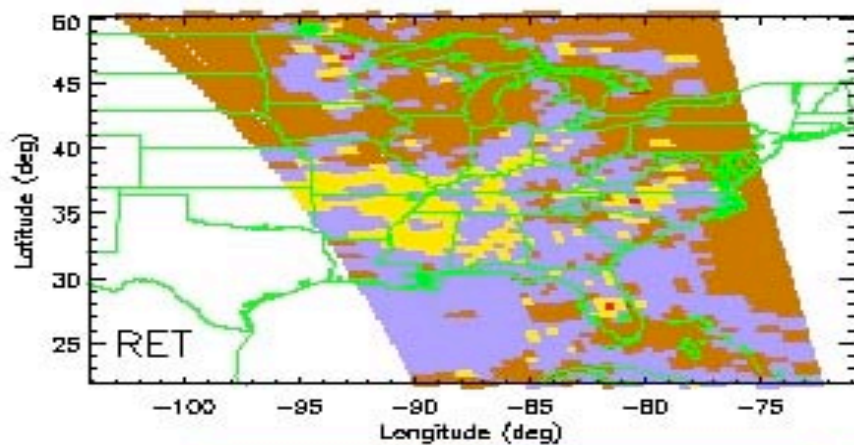
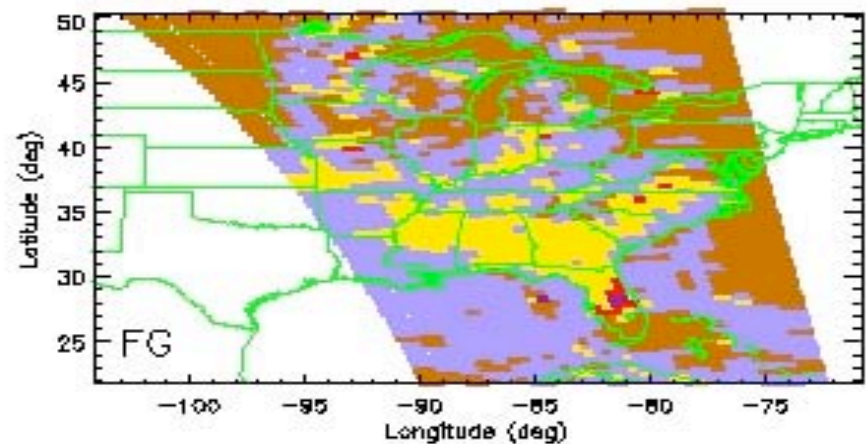
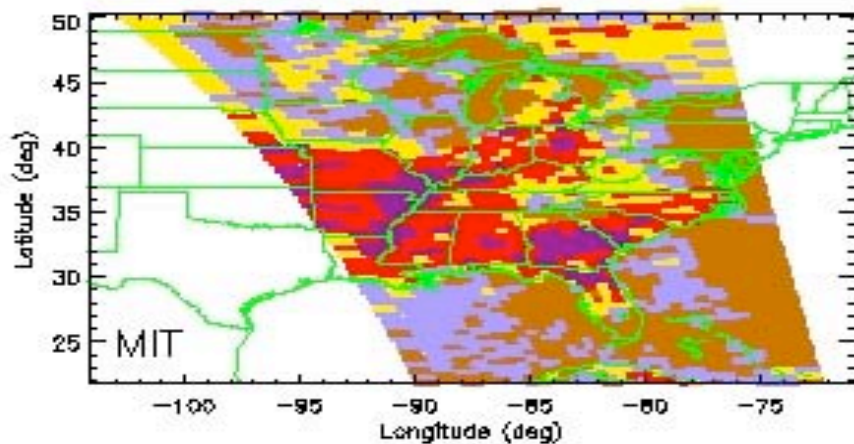
# Maximum CAPE: Lift parcel from the layer of maximum ( $\theta_e$ )



# Surface-based LI: Lift parcel from surface



# Maximum LI: Lift parcel from the layer of maximum $\theta_e$



# Summary



- The implementation of the algorithm is an simple interface — can add and reduce instability parameters as users request.
- Convective parameters can be computed from MIT, regression, and physical retrieval.
- CAPE, CIN and LI are good indicators of the potential for strong thunderstorms and severe weather.

# Future Plans



- Convective products from AIRS and IASI, 4 times/day
- Near real-time system, explore the utility of
  - evolving storm warnings (Nowcaster community)
  - minimizing false alarms